Dec. 2, 1958 O. A. YOST 2,862,548

SELF-POWERED AGITATING EVAPORATOR

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FIG. 1.

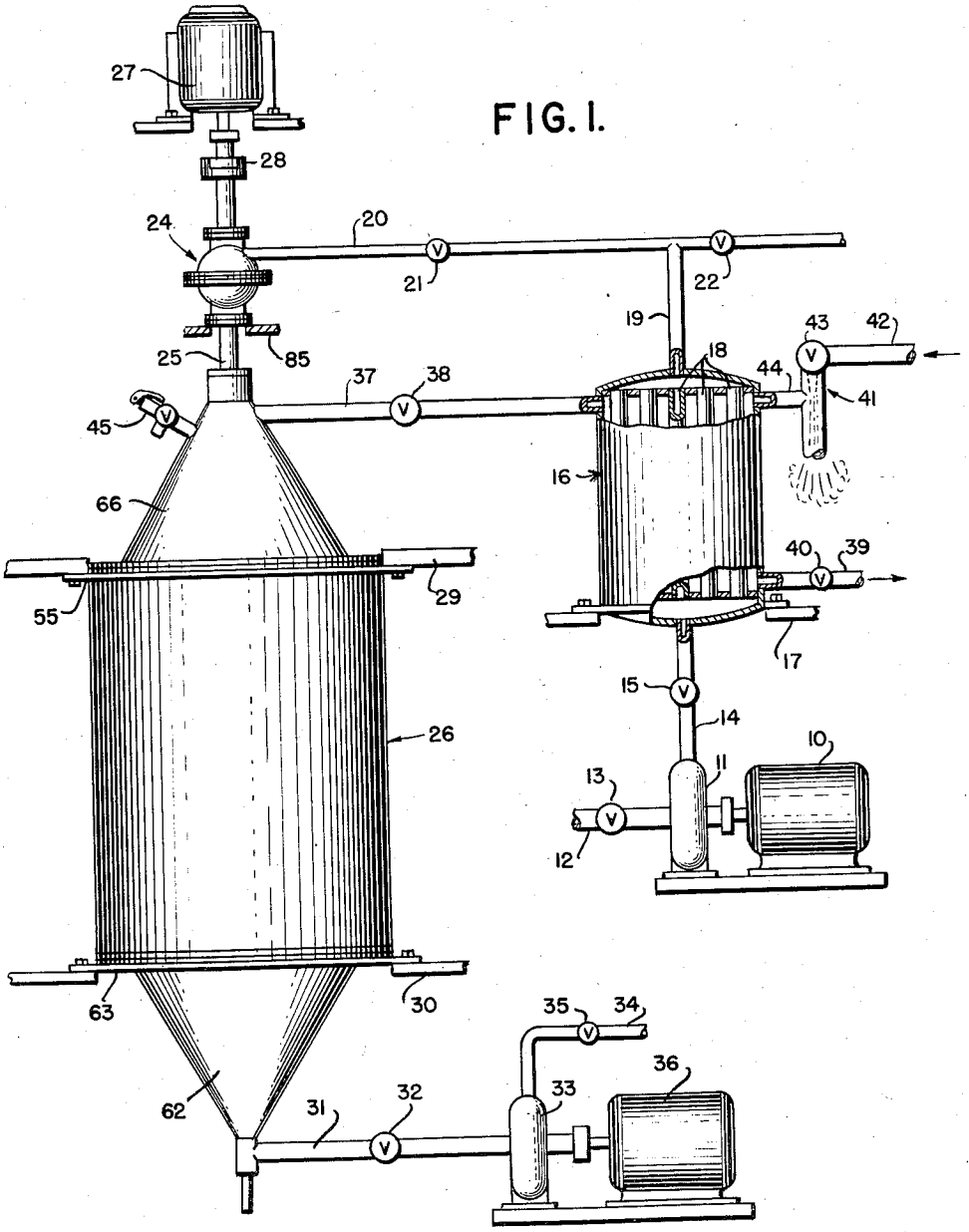

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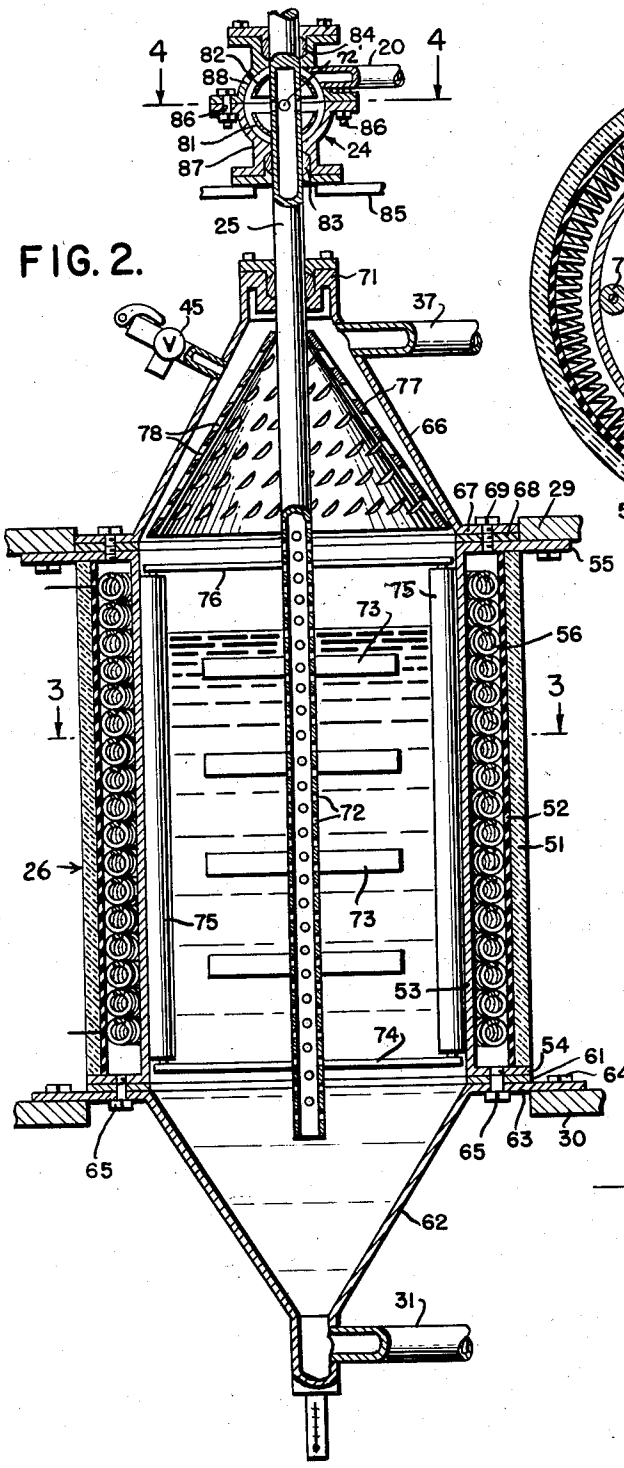
FIG. 2.



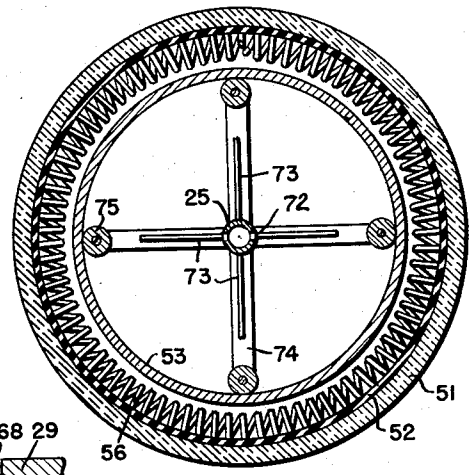


FIG. 3.

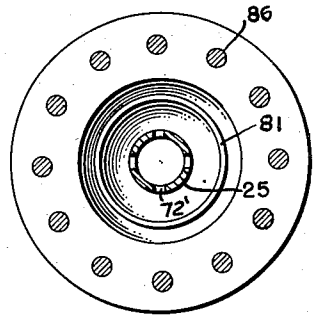


FIG. 4.

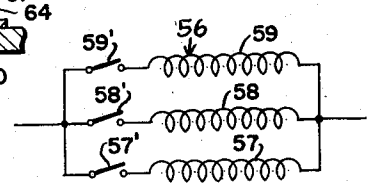


FIG. 5.

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SELF-POWERED AGITATING EVAPORATOR

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Application February 11, 1957, Serial No. 639,270

9 Claims. (Cl. 159—25)

This invention relates to evaporating systems and more particularly to a system for providing fresh water from salt water and to the construction of the evaporator unit.

It is the principal object of the present invention to provide an evaporator unit for salt water evaporating systems which will be maintained in a clean condition at all times free of scale and salt deposits on the walls of the evaporating chamber.

It is another object of the invention to provide a self-powered agitating evaporating unit whereby to render such systems more effective and efficient.

It is still another object of the invention to provide in an evaporator unit hollow vertically-extending rotary agitating paddle shaft for supplying to the evaporating unit the salt water or other solution to be treated on which is mounted a propelling cone having angled perforations through which the vapor rising within the evaporator unit is caused to expand and in so doing will render an impelling force that turns the cone and the shaft and thereby maintains movement of the brine solution being evaporated.

It is a further object of the invention to provide an agitating paddle shaft of an evaporator until with laterally-extending upper and lower supporting arms carrying vertically-extending rollers adapted to roll upon and sweep the wall surface of the chamber and to break up any scale deposits that may tend to form thereon whereby to maintain this surface free of scale deposits.

Other objects of the invention are to provide a self-cleaning evaporator unit, having the above objects in mind which is of simple construction, has a minimum number of parts, compact, and consumes little space, easy to maintain, self-powered, inexpensive, self-baffled, efficient and effective in use.

For a better understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawing, in which

Figure 1 is a diagrammatic elevational view of the evaporating system employing the present evaporator unit,

Fig. 2 is an enlarged vertical sectional view of the evaporating unit,

Fig. 3 is a transverse sectional view of the evaporating unit taken on line 3—3 of Fig. 2,

Fig. 4 is a plan view of the combined thrust bearing and water inlet connection and agitating shaft, the view looking upon the lower half of the bearing housing and as viewed on line 4—4 of Fig. 2, and

Fig. 5 is a wiring diagram for the heating units.

Referring now to the figures, and in particular to Fig. 1, the evaporating system employing the present evaporating unit will be generally described. An electric motor 10 drives a centrifugal intake pump 11 which draws salt water or other liquid through an inlet pipe 12, having a valve 13, from the sea or from any other liquid body containing the liquid to be treated. This water or liquid is directed upwardly through a delivery pipe 14, having a valve 15 therein, into a condenser 16 supported on a frame structure 17 and having a tube nest 18 in the condenser 16

through which the liquid passes and outwardly through a pipe 19 to a delivery pipe 20 having a valve 21 therein. This pipe 20 has also a valve 22 at the opposite side of the pipe 19 for the discharge of excess water and to maintain the cooling water temperature in the condenser. The pipe 20 leads to a combined inlet and thrust bearing unit 24 for delivering the water to the hollow agitating shaft 25 of evaporating unit 26. An electric motor 27 is connected to the agitating shaft 25 to rotate the shaft at times when the system is started and when the system is under high pressure operation. The connection of the motor with the shaft 25 is effected through a clutch 28. The evaporator unit 26 is mounted on upper and lower frame members 29 and 30. The excess more concentrated salt solution or sludge in the bottom of the evaporator chamber is continuously withdrawn through a pipe 31 having a throttle valve 32 and connected with a blow down brine pump 33 and discharged through an outlet discharge pipe 34 having a valve 35 therein. An electric motor 36 drives the pump 33.

The steam vapors leave the top of the evaporator through a pipe 37, having a valve 38 and are delivered to the condenser 16 so as to be passed about the tubes of the tube nest 18 thereof so that the vapors will be condensed by the cold water passing upwardly through the tube nest. The final distillate leaves the condenser through a pipe 39 having a valve 40. A steam air ejector device 41 supplied with steam from a pipe 42 and having air ejector valve 43 is connected to the condenser shell by a pipe 44 to eject air at the beginning of the operation and maintains thereafter the vacuum within the system and upon the top of the water body being evaporated. A safety valve device 45 is provided on the top of the evaporator unit 26.

The evaporator unit comprises a cylindrical outer shell 51 which is lined with heat and fire insulation 52 and an inner shell 53 having lower and upper flanges 54 and 55 for supporting the outer shell 51. These shells are concentric and in annular space between them there is provided an electric heating coil system 56. The electric heating system is shown diagrammatically in Figure 5 and includes preferably step heating coils 57, 58 and 59 throughout the height of the evaporator. The different coils of the electric coils can be added to one another through switches 57′, 58′ and 59′ to have more heat. There are times when the operation requires only small heat as when the evaporator needs to be operated only under low pressure and the ejector device 41 is being used.

Connected to the lower flange 54 through a gasket 61 is a bottom funnel shaped member 62. This funnel member 62 has a wide top flange 63 that serves as a support for the evaporator by means of which the evaporator is connected by bolts 64 with a lower supporting frame 30. Bolts 65 secure the flange 63 with the flange 54 and by virtue of the gasket 61 therebetween provides for a water tight connection.

On the top flange 55 there is mounted a conical top member 66 having a flange 67 that is secured to the flange 55 through a gasket 68 by fastening bolts 69. The pipe 37 leads off from the upper end of the member 66. The upper end of the member 66 has a packing structure 71 in which the shaft 25 rotates.

The shaft 25 is hollow from a point above the combined water inlet and thrust bearing assembly 24 to its lower end that extends into the bottom member 62 of the evaporator. The shaft is perforated throughout the height of the shells and open at its lower end. The liquid to be treated is taken into the hollow shaft through the holes 72′ in the bearing assembly and enters the space within the evaporator through these perforations 72 and the lower end of the shaft. Vertically-spaced and extending radially outwardly from the shaft are sets of agitating

blades 73. There are four blades in each set and upon the shaft 25 being rotated these blades will maintain the liquid body within the evaporator in motion at the different elevations therein. Near the lower end of the shaft 25 is a lower spider supporting structure 74 in which the lower ends of vertically-extending rollers 75 are journalled to roll upon the inner surface of the heated shell 53 to break up any scale deposits tending to be formed thereon. The upper ends of the rollers 75 are journalled in an upper spider structure 76 secured to the shaft 25.

It will now be apparent that the liquid body within the evaporator is kept constantly in motion and any sediment or crystallization tending to be formed on the inner shell 53 is kept broken and prevented from growing within the evaporator chamber. The more saturated solution is also being continuously withdrawn from the bottom of the evaporator and the liquid therein thereby further kept in motion.

Fixed to the shaft 25 within the conical top member 66 is a combined baffle turbine-like driving member or vane 77 of conical shape having propelling openings 78 shaped to cause the baffle member to be driven by expansion of low pressure steam passing through them. When the evaporator is operating under high pressure the electric motor 27 is connected through clutch 28 and the shaft 25 will be self-driven under the pressure from the steam and resulting from the vacuum from the ejector 41. The baffle member 77 substantially closes the lower end of the top member 66 and requires the flow of steam to pass through the angled openings 78 in a circuitous path thereby to restrict the flow of the steam from the evaporator and to maintain the pressure therein.

The combined inlet and thrust bearing arrangement 24 for the shaft is formed of separable lower and upper parts 81 and 82 each of which respectively having a packing gland 83 and 84 to surround the shaft 25 and to prevent leakage of water along the pipe. This assembly is supported on a frame 85. The two parts 81 and 82 are joined to one another by fastening bolts 86. The delivery pipe 20 enters the upper part 82. Fixed to the shaft 25 within the delivery pipe assembly are opposing cup shape members 81 and 82 that are spaced from one another on the shaft and also spaced from the rounded interiors of the parts 87 and 88. A series of holes 72' are provided in the pipe to deliver the water or liquid to the interior thereof so that it may be conducted downwardly into the separator chamber. Any upward thrust of the shaft 25 resulting from pressure in the evaporator will be absorbed by this assembly 24.

It should now be apparent that there has been provided an evaporator unit for salt separating systems and the like which provides means for preventing the accumulation of sediment and sludge within the evaporator and wherein the agitating means can be self-powered.

It will be apparent that the cone 77 with the angularly deflected openings is in the form of a turbine like vane and that as the vapors expand through the openings the vane is turned and the shaft 25 with the paddles 73 and the rollers 75 thereon will be similarly turned. The vapor generated from the heated waters as they pass through the vane openings create an angle of deflection to move the vane. The pressures will gradually fall off through the pipe 37 because of the vacuum pressure effected by the air ejector 41 attached to the condenser or distillate 16. The liquid within the evaporator will thereby be kept in motion and the scale deposits will be kept free of the inner shell.

It should also be apparent that this evaporator is designed for dual operation. When it is run at low pressure and under a vacuum created by the air ejector 41 the driving of the shaft can be effected by the vane cone but upon operating under high pressure as when all the heating coils are turned on the drive can be effected by the electric motor 27 and the air ejector 41 turned off.

To start the operation of the system the evaporator is

filled to the proper level by the pump 11 with sea water or any other liquid which is to be treated and discharged through the condenser 16 and pipe 37 into the top of the evaporator. The level of the liquid in the evaporator will be brought to a location above the paddles 73. One of the electric heating coils can be turned on to provide low heat and the vapors produced by the heat and the vacuum drag on the cone will cause the paddles and rollers 75 to be rotated within the evaporator. The vapors leaving the liquid level in the shell will operate the vane 77 on a turbine principle of the angle of deflection of the vapors through the vane openings and the gradual falling off of the pressures caused by the air ejector. Purer distilled water will be made at a reduced cost than by any of the evaporators now in use. More water will be produced by an easier and simpler operation. The evaporator will at no time have to be shut down to remove scale deposits on the chamber wall surfaces. The inner wall is preferably made of copper and as a result of the rolling effect of the roller thereupon it will be maintained clean without need for chemical washings, without hand cleaning or steam shock treatment. Salt water density is about one part solid to thirty-two parts water and in the operation of the conventional evaporators the salt water density is never allowed to get over one and one half parts solid to thirty-two parts liquid. By having the present roller descaling arrangement it is possible to permit the density of the solution to reach around two parts of solid to thirty-two parts liquid with comparative safety. The conical shape bottom member 62 gives the heated liquid a faster gravitational centralized density to the brine pump so that the valve 35 can be closely adjusted to give less heat power loss than with the conventional evaporators now in use. Inasmuch as the discharge density of the brine pump can be operated by two parts of solid and thirty-two parts liquid this provides an evaporator system that is ideal for the production of minerals from salt water because a more concentrated brine discharge is possible.

The paddles 73 will agitate the heated waters and break its molecular seal thus creating a faster passage of the vapors through the vane and thereby tend to increase the speed rotation of the vane and give added cleaning effects by the rollers.

The interior of the cone or vane 77 provides an effect as it is being rotated and active and of an extended baffle that serves to prevent vapors having impurities from leaving the evaporator to reduce priming hazards.

The baffle effect increases with the speed of the operation of the cone and a final and purer distillate results. The evaporator can be watched by looking at its rotational speed by looking upon a mark at lower half of the clutch part. The need for numerous instruments and saline indicators now used on the present evaporators will be eliminated. Since the evaporator feed water passes through the condenser it will be preheated before entering the evaporator unit and as it passes downwardly through the perforated pipe, it will again absorb more heat before it passes through the perforations of the shaft into the body of the solution thereby further improving the economy of the system.

With the system being used at high pressure, that is with all of the electric heating units turned on and without the vacuum, the vapors will pass to the condenser at very high temperature and the water be sufficiently pure even though the liquid treated be from a contaminated source or sewage. With the higher temperature and pressure operation, the variable speed motor 27 is used to rotate the shaft 25 by engagement of the motor with the shaft through the clutch 28.

The evaporator when not in use can be cleaned by steam shocking. This method can be more easily performed with this type of evaporator than with those now in use since the shells can be emptied of the brine and the cleaning water circulated at full capacity through the evaporator with the paddle shaft and deposit eliminating

rollers rotated by the motor and with the heat turned on so that cleaning and shocking can thereby be effected with little effort or attention.

While various changes may be made in the detailed construction, it shall be understood that such changes shall be within the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. An evaporating unit comprising top and bottom end members, a hollow shaft extending from the interior of the evaporating unit through one of the members, a combined thrust bearing and water delivery assembly surrounding said shaft and adapted to support the shaft within the evaporating unit, pipe means for delivering feed water to the combined thrust bearing and water delivery assembly, outlet means extending from the top member, and said shaft having paddle blades thereon, and means for driving said shaft.

2. An evaporating unit as defined in claim 1, said evaporator having an internal wall surface, and said shaft having roller elements engaging with the wall surface to break up any deposits tending to be formed thereon.

3. An evaporating unit as defined in claim 1, and said driving means including a conical vane baffle fixed to the hollow shaft at the upper and of the evaporating chamber, and having angularly deflected openings therein through which the vapor may expand to cause the conical vane and the shaft to rotate.

4. An evaporating unit as defined in claim 3, and said shaft rotating means further including an electric motor and a clutch between the motor and the shaft whereby said shaft may be rotated either by the conical vane baffle or by the electric motor.

5. An evaporating unit comprising concentric inner and outer shells, heating means disposed between the inner and outer shells, top and bottom members, a hollow shaft extending through one of the members, means for driving said shaft, said driving means having a turbine-like vapor cone through which the vapor may be exposed and thereby cause rotation of the vane and the shaft, and vertically-extending members connected to said shaft to be driven thereby and adapted to sweep over the inner surface of the inner shell to break up and rid the same of any deposits tending to be formed thereon.

6. An evaporating unit as defined in claim 5, and paddle blades on said shaft for agitating the solution within the evaporation.

7. An evaporating unit as defined in claim 6, and said means for driving said shaft being in the form of a turbine like vane fixed to the shaft and having angularly-deflected openings through which the vapors may expand thereby to cause rotation of the vane and said shaft within the evaporator.

8. An evaporating unit as defined in claim 7, and a combined thrust bearing and liquid inlet assembly surrounding the shaft externally of the evaporator unit.

9. An evaporating unit as defined in claim 8, and an electric motor and clutch means for selectably engaging the motor with the shaft so that the shaft may be driven either by the vane or the electric motor.

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